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Occupational Health and Safety Division

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Occupational Health in Ontario

Volume 3, Number 1, January 1982

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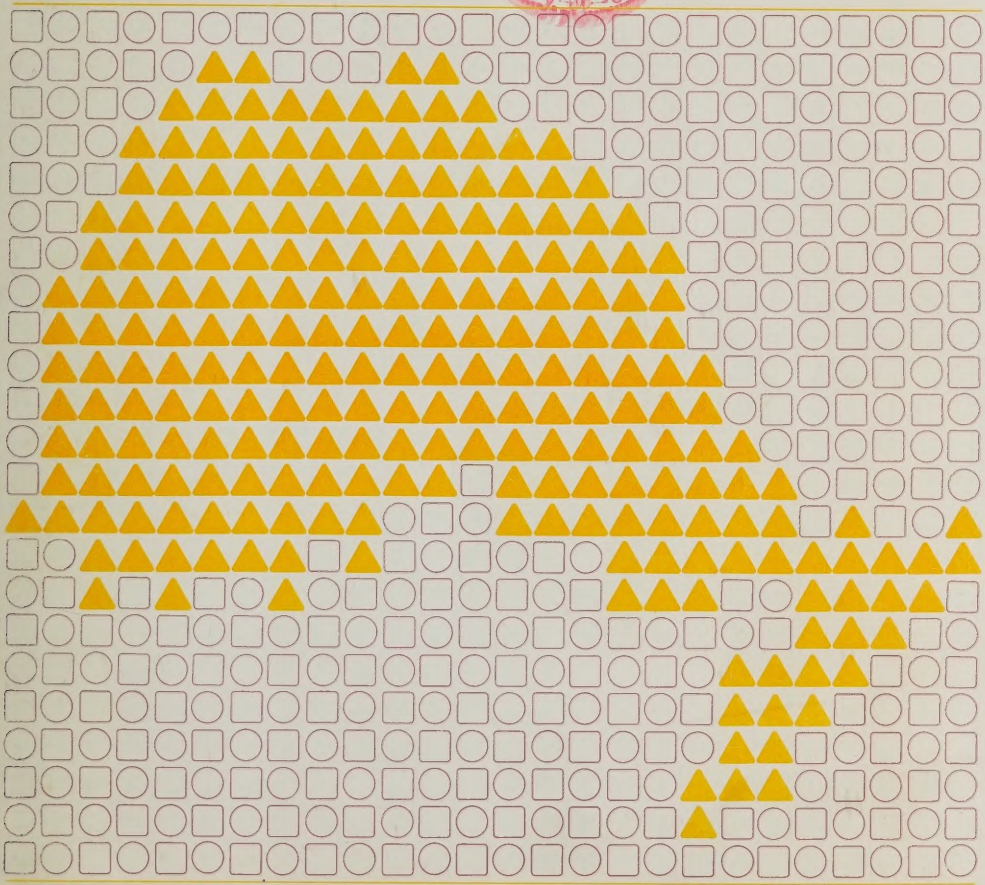

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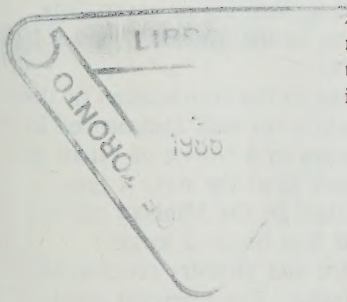

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2. Department of Health and Social Security. Notes on the diagnoses of occupational diseases, rev ed 1972; London HMSO.
3. Gamble JF, and Battigelli MC. Epidemiology. In: Clayton GD and Clayton FE. eds. Patty's industrial hygiene and toxicology. New York: McGraw Hill, 1978: Vol 1; 113-116.

P. Dietrich, LL.B
W. Watson*, LL.B

Lead—Ontario's First Designated Substance

Summary

The lead regulation for Ontario is discussed with particular reference to its application, assessment of the work place, control programs, physicians' responsibilities and confidentiality.

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Ontario Regulation 536/81, a regulation respecting lead and related codes made under the *Occupational Health and Safety Act*, was filed with the Registrar of Regulations for the province of Ontario on August 14, 1981 and thus became the first of a series of proposed designated substance regulations made under the *Occupational Health and Safety Act*, R.S.O. 1980, Chapter 321 ('the Act') to come into force.

Lead and its associated health effects have been the subject of much investigation and debate within the province and it was determined that occupational exposure to lead was a matter that would have to be addressed by way of a designated substance regulation in order to ensure that workers in the province of Ontario were adequately protected from the adverse effects of exposure thereto.

Section 2 of the regulation prescribes lead as a designated substance. This is done pursuant to subsection 41(2)14 of the Act, which enables the Lieutenant Governor in Council to prescribe any biological, chemical or physical agent as a designated substance. Once a substance has been designated, then pursuant to subsection 41(2)15, regulations can be made prohibiting, regulating, restricting, limiting or controlling the handling of, exposure to, or the use and disposal of, the designated substance.

The formal process leading to the formulation of the designated substance regulation for lead commenced in June 1980 with the publication of a Notice of Intent to Designate pursuant to section 22 of the Act. A proposed regulation was published by the Ministry of Labour in August 1980 and thus began a lengthy process of public reaction to, and ministry revision of, the original proposed regulation. The amended regulation was presented to a public forum of concerned parties in March 1981 and a number of additional comments and briefs followed.

In the light of these representations and with the advice and assistance of the Advisory Council on Occupational Health and Occupational Safety, the ministry formulated the existing regulation, which received the approval of cabinet in the summer of 1981, and it was filed on August 14, 1981.

The lead regulation incorporates a number of novel concepts and approaches and while these concepts and approaches share a degree of propinquity, they have not previously been linked in any legislative initiative of the Ministry of Labour. The concepts and approaches referred to above include:

a) an assessment of the work place;
b) a control program;
c) a regulation providing duties and responsibilities for employers, workers, joint health and safety committees and physicians that are different from, and are in addition to, those provided in the Act;
d) the internal responsibility system;
e) time-weighted average exposure levels;
f) mandatory medical examinations and clinical tests for workers;
g) engineering controls, work practices, hygiene practices and facilities as control measures;
h) the maintenance of exposure records and medical records and their retention over the working life of the worker;
i) mandatory removal of a worker from exposure under prescribed circumstances;
j) confidentiality of health information;
k) legally enforceable codes of practice not in the regulation itself though referenced therein; and
l) the concept of equivalency with the codes referenced in the regulation.

Because the lead regulation may be considered a prototype for ensuing designated substances regulations, it is essential that occupational health professionals should familiarize themselves with the major scope and approach of the lead regulation in order to ease the period of transition from the *status quo ante* to the new approach with respect to occupational health regulation in the province of Ontario. This article is an attempt to interpret and explain the basic principles and parameters of the lead regulation and to alert occupational health professionals to the novel nature of designated substance regulations for Ontario.

The Subject Matter of the Regulation

Lead is found in a great many forms and different states and, as a consequence, many employers and employees will be unaware of the potential exposure to lead and, indeed, unaware of the very presence of lead in their respective workplaces.

Lead is defined in the regulation to mean elemental lead, inorganic compounds of lead and organic compounds of lead. While this definition is technically exhaustive, it does not assist the employer or employee in the determination of whether or not the substances with which they deal contain lead. To rectify this shortcoming, the ministry is preparing explanatory materials that will provide illustrations of substances falling within each of the respective categories within the definition of lead in the regulation. For instance, examples of elemental lead include ammunition, and solder used in electrical or plumbing work; an example of an organic compound of lead is tetraethyl lead, which is used as an anti-knock ingredient in gasoline; an example of an inorganic lead compound is lead nitrate used in photography and the tanning industry and found in matches, pigments and explosives.

The various forms and processes using lead are so pervasive that it is likely that lead will be found in a significant number of Ontario workplaces.

Application of the Regulation

Subsection 3(1) of the regulation establishes the parameters for the application of the lead regulation as follows: 'This regulation applies to every employer and worker at a workplace where lead is present, produced, processed, used, handled or stored and at which the worker is likely to inhale, ingest or absorb lead.' It is important to appreciate the two conditions that must co-exist in order that this regulation apply to a workplace. These conditions are:

1. that lead is present in the workplace in some form; and
2. that a worker is likely to inhale, ingest or absorb some of the lead that is present in the workplace.

In other words, if lead is present in the workplace, but there is no likelihood of worker exposure, the regulation does not apply. Such a situation would arise, for example, where lead is present in a workplace in sealed containers or aprons. In such instances, lead is present in the workplace, but there is clearly no likelihood of worker exposure.

It is important to note that the application section of the regulation does not make application of the regulation dependent upon either:

1. the presence of a particular quantity of the designated substance, or
2. any particular degree of exposure of a worker to the designated substance.

Consequently, the presence of any quantity of the designated substance in a workplace combined with a likelihood of exposure to the designated substance will result in the application of this regulation.

The safety regulations made under the *Occupational Health and Safety Act* have traditionally provided for a sectorial or industrywide application. Each regulation was designed for, and made applicable to, specific workplaces; for example, the industrial establishment regulations apply only to industrial establishments as defined in the Act. In contrast, the new designated substance regulation states that the regulation applies to every employer and worker at a workplace where the conditions specified in subsection 3(1) exist. As a consequence, there is no sectorial limitation on the application of the regulation and therefore the regulation applies to all workers and employers covered under the Act. This application, which applies to workers as opposed to workplaces, can perhaps best be explained by the fact that the lead regulation is a health related regulation that addresses a hazard that has no particular relationship to a specific type of workplace since the health of a worker can be affected by exposure to lead in any workplace in Ontario.

Workers who work at or on a construction project have been exempted from the application of the regulation except in a circumstance where the construction is being carried out at a workplace to which the lead regulation otherwise applies. Where, for example, construction is being carried out at a lead processing plant, the employer who is responsible for that workplace is charged with certain responsibilities with respect to the protection of the construction workers from exposure to lead in that plant. The responsibility of the employer at whose workplace the construction is being carried out with respect to the protection of the construction workers from exposure to lead in the workplace, is limited to ensuring that the exposure limits established in the regulation are complied with by means of engineering controls, work practices and hygiene practices and facilities or by means of the use of respirators, where such use is authorized by the regulation.

Consequences Arising upon the Application of the Regulation to a Workplace

Where the regulation applies to a workplace, employers, workers, members of the joint health and safety committee and physicians are given duties and responsibilities pursuant to the regulation which, in certain respects, differ from or are in addition to those duties and responsibilities outlined in the Act. The creation of additional duties and alteration of existing duties found in the Act is a quite different approach from that utilized in the safety regulations made under the Act.

An important consequence of the application of a designated substance regulation to a workplace is that arising from subsection 8(2)(b) of the Act. This section requires a joint health and safety committee to be established in the workplace if a designated substance regulation applies thereto. This requirement exists regardless of the number of workers in the workplace. As a consequence of the application of the lead regulation, a number of workplaces that would not otherwise have been required to formulate a joint health and safety committee due to the fact that less than 20 workers are regularly employed therein, will now be required to do so. The effect of such a provision may be to require the establishment of a joint health and safety committee in workplaces where as few as one worker is regularly employed. It will be apparent that with the advent of a significant number of designated substance regulations, the presence of a joint health and safety committee in the workplace may become the rule rather than the exception.

The necessity of having a joint health and safety committee in a workplace to which a designated substance regulation applies is reflected in the lead regulation in various provisions that rely implicitly upon an internal responsibility system functioning effectively within the workplace. It is through the internal responsibility system that the workers are entitled by the regulation to have input into the assessment process and the establishment of the Lead Control Program, to receive information on the health of workers exposed to lead and to gain access to the dispute settling mechanism established in the regulation.

Duty to Perform an Assessment

The initial duty that the regulation, where it applies, imposes on an employer is to cause an assessment to be made in writing of the exposure or likelihood of exposure, in the workplace, of a worker to the inhalation, ingestion or absorption or lead. While the term assess-

ment is not defined in the regulation, it is apparent that the assessment must consider the type of lead present in the workplace and the nature of its presence, the extent to which workers are exposed to lead in the workplace and the possible procedures available to the employer for controlling such exposure.

The manner by which the assessment is conducted is a matter for the discretion of the employer after consulting with the joint health and safety committee. As noted above, every workplace to which the regulation applies must have a joint health and safety committee to carry out the consultative function assigned to it. It is important to note that it is at the assessment stage where the first consideration is given to the extent of worker exposure to lead.

Because the regulation requires that the assessment be done in writing, a copy of the assessment will normally be kept on file by the employer and, consequently, will be available for review by inspectors of the Ministry of Labour. The regulation specifically requires the employer to furnish a copy of the assessment to each member of the joint health and safety committee for review.

Two results may follow from the assessment. The assessment may disclose that some workers are likely to inhale, ingest and absorb lead and, additionally, that the health of one or more workers may be affected thereby. If this is the case, the employer must establish a lead control program. Conversely, the assessment may disclose that despite the fact that some workers are likely to inhale, ingest or absorb lead, there is no likelihood that their health will be affected by such exposure. In such a situation no further action is required on the part of the employer.

Even though the assessment may disclose that a lead control program is unnecessary and that further action on the part of the employer is not mandatory, the joint health and safety committee continues in existence so long as the regulation applies to that workplace. The rationale for the continued existence of the joint health and safety committee is the ongoing duty to monitor the workplace for any changes of a significant nature that might require a further assessment to be conducted.

A subsequent assessment is required in each instance where a significant difference occurs in the exposure of workers to lead as a consequence of a change in the process involving lead or a change in the methods and procedures involved in the use, handling or storage of lead. Like the initial assessment, this assessment is the

responsibility of the employer, who is required to consult thereon with the joint health and safety committee.

A subsequent assessment may have a number of consequences, depending upon the conditions in the workplace at the time the subsequent assessment is undertaken. Where a lead control program is already in place, the subsequent assessment may indicate that there is a need for more stringent provisions in the lead control program or, alternatively, that less stringent provisions would be appropriate or that a lead control program was no longer required at all. On the other hand, the circumstances may have been such that the initial assessment disclosed no need for a lead control program. In this instance, a subsequent assessment may give rise to a duty on the employer to implement a lead control program.

To recapitulate, it is apparent that the consequence of the application of the regulation to a workplace is to create an incremental program designed to protect workers from undue exposure to lead. Initially, one must determine whether the regulation itself applies to the workplace, taking into account the two conditions precedent for the regulation to apply, these being:

1. presence of lead in the workplace, and
2. a likelihood of the inhalation, ingestion or absorption of lead by workers in the workplace.

If the initial determination is that the regulation applies, then a joint health and safety committee is required to be established unless there is already a joint health and safety committee in the workplace. After the joint health and safety committee has been established, the employer must cause an assessment to be made in writing and, in doing so, must consult thereon with the joint health and safety committee. The assessment determines whether or not a lead control program is required in the workplace, which determination depends upon whether the health of any worker may be affected by exposure to lead. Whatever the outcome of the initial assessment, both the employer and the joint health and safety committee should remain on the alert for any significant difference in the exposure of workers to lead resulting from a change in the processing, use, handling or storage of lead, which may warrant further assessment with its concomitant effects on the lead control program.

The Lead Control Program

A lead control program is required in a workplace where workers are likely to inhale, ingest or absorb lead and suffer health effects as a consequence. The actual provisions of the lead control program are determined by the employer after consultation with the joint health and safety committee. Thus it is the conception of the regulation that each workplace will have its own unique lead control program. No two programs will be exactly alike. However, there will be many similiarities. This 'different yet similiar' dichotomy results from the fact that the lead control program must meet a combination of mandatory and discretionary provisions. Because the nature of the presence of lead and the nature and extent of the exposure of workers thereto will be different in each distinct workplace, it has been necessary to leave some of the details of the lead control program to the discretion of the parties involved. The theory is that the internal responsibility system can fashion a program that is best suited to the needs of the particular workplace. However, there are certain aspects related to the control of worker exposure that are absolutely essential in any lead control program, and the regulation details these mandatory requirements.

Thus, within the parameters of every lead control program are the following mandatory measures and procedures:

a) engineering controls, work practices, hygiene practices and facilities to control the exposure of a worker to lead;
b) methods and procedures to monitor the concentration of airborne lead in the workplace and the exposure of the worker thereto;
c) personal records of the exposure of the worker to lead at the workplace to be maintained by the employer;
d) medical examinations and clinical tests of a worker;
e) records of medical examinations and clinical tests of a worker to be maintained by a physician who has examined the worker or under whose direction the clinical tests have been performed.

While provision for these measures and procedures in each lead control program is mandatory, the specific details respecting the provisions are, in certain respects, left up to the concerned parties and, in other respects, are subject to further provision of the regulation. For example, with respect to the medical examinations, the

employer, after consulting with the joint health and safety committee, can determine such matters as who will undergo the medical examinations, how often medical examinations will be required and who will conduct such examinations. However, the extent of the examination and action consequent thereon are required to be in accordance with the further applicable provisions of the regulation and the Code for Medical Surveillance.

Similarly, the need for and the extent of engineering controls, work practices and hygiene practices in the lead control program is determined by reference to the time-weighted average exposure provision of the regulation. The actual type of controls and the manner of implementing work practices is within the discretion of the employer. A prudent employer may deem it expedient to consult thereon with the joint health and safety committee.

The methods and procedures for monitoring the concentrations of airborne lead are specifically set out in the Code for Measuring Airborne Lead. In addition, the regulation stipulates that the results of this monitoring must be posted by the employer in the workplace as soon as possible, for a period of at least 14 days; given by the employer to the joint health and safety committee; and kept by the employer in his records for a period of at least five years.

The contents of the personal exposure records required to be maintained by the employer must, as a minimum, include the worker's name, date of birth, the worker's job or occupation in the workplace, the results of monitoring for exposure to airborne lead in his or her work area and the use by the worker of respiratory equipment and its type. The regulation then requires that the entire contents of these personal exposure records be forwarded by the employer to the physician examining the worker.

Finally, there are three duties relating to the communication of the contents of the lead control program that are placed on the employer. The employer must furnish a copy of the lead control program to the joint health and safety committee, from which it can be inferred that the provisions of the lead control program must be in writing. Secondly, the employer must acquaint every worker affected by the program with its provisions. Thirdly, where English is not the majority language of

the workplace, the employer is required to supply a translation of the provisions contained in the lead control program.

Dispute Resolution

In addition to the enforcement provisions to be found in the Act, the regulation provides a unique dispute settling mechanism. This mechanism is found in section 9 of the regulation. The issues that can be raised under this procedure are specifically limited. Only questions of the need for an initial or subsequent assessment, the adequacy of the assessment conducted, the need for a lead control program or the adequacy of the lead control program or its provisions can be raised.

The dispute over one of these issues must inherently arise between the employer and the joint health and safety committee. Thus, not surprisingly, only the employer, a member of the joint health and safety committee or the committee itself can utilize this procedure. It is clear that the limitation in this section is a reflection of the reliance on the internal responsibility system generally to give substance and form to the assessment and to the lead control program since it is the employer in consultation with the joint health and safety committee that is required to determine these two matters. The theory of the regulation is that the joint health and safety committee will develop an expertise with respect to the workplace and the health and safety concerns unique thereto. Hence, it follows that if the joint health and safety committee does not perceive a problem, it is unlikely to exist. The regulation indicates the desire on the part of the Ministry of Labour to have the parties concerned work out these issues, identify the hazards and deal with them accordingly. Where the parties have agreed that the measures and procedures that they have implemented will deal adequately with the situation, it is not generally the intention of the Ministry of Labour to become involved. However, where there is an obvious failure in the functioning of the internal responsibility system, intervention will undoubtedly follow.

Where the intervention of an inspector is precipitated by either the employer, joint health and safety committee or a member of the committee, the regulation imposes a duty on the inspector to investigate the matter and to give a decision in writing.

The Exposure Limit Levels

Section 4 of the regulation establishes the exposure levels for lead. The duty is on the employer to ensure that the exposure levels are not exceeded. The regulation sets two different types of exposure levels: a time-weighted average exposure level and a maximum concentration exposure level. Within each of these types there are two different levels, depending on the type of lead to which a worker is exposed.

The maximum concentration levels are as follows:

1. in the case of tetraethyl lead – 0.30mg lead per m^3 of air; and,
2. in the case of other airborne lead – 0.45mg lead per m^3 of air.

Not only are there maximum concentrations to which a worker may be exposed, but there are, as well, limits imposed on the frequency to which a worker may be exposed to those maximum concentrations. Thus, exposure of a worker to the maximum concentration levels:

1. shall not exceed 15 minutes at any time;
2. shall not occur more than four times in a work day; and,
3. shall not occur until at least 60 minutes have elapsed from the time of the last previous exposure to such concentrations.

However, a worker can be exposed to levels below the maximum concentration levels for any amount of time and for any frequency provided that the time-weighted average exposure levels are not exceeded.

The time-weighted average exposure levels are as follows:

1. in the case of tetraethyl lead – 0.10mg lead per m^3 of air; and,
2. in the case of other airborne lead – 0.15mg lead per m^3 of air.

These levels are calculated over a 40-hour work week as provided for in the schedule attached to the regulation. As a consequence of the time-weighted average exposure levels, it is unlikely that a worker can be exposed to levels approaching the maximum concentration levels for any substantial degree of regularity or length of time without thereby exceeding the time-weighted average exposure levels.

The time-weighted average exposure levels and the maximum concentration levels must be met either by way of engineering controls, work practices or hygiene

practices or facilities unless one of the exceptions detailed in section 5 of the regulation exists. Where this is the case, the employer is permitted to control the exposure to lead by means of the use of respiratory equipment. The onus is on the employer to show that one of these exceptions exists before requiring the use of respirators.

The regulation allows respirators to be utilized to control worker exposure to lead in the following instances:

1. where an emergency exists; or
2. where the measures and procedures necessary to control the exposure of a worker to airborne lead
   a) do not exist or are not available;
   b) are not reasonable or practical for the length of time or frequency of exposure or the nature of the process, operation or work;
   c) are not effective because of a temporary breakdown of equipment.

The term 'reasonable or practical' can be interpreted to include both economic and technical feasibility. In light of such an interpretation, if, for the length of time that the exposure is likely to occur, it would not be economically feasible for an employer to utilize engineering controls to achieve the exposure levels required, it would be permissible for the employer to require the use of respirators.

Where respiratory equipment is provided and used, the equipment so provided must comply with or exceed the requirements set out in the Code for Respiratory Equipment for Lead. The employer is also required to provide training and instruction to the worker using the respirator in the proper care and use of that respirator. Where the regulation permits the employer to require the use of respirators, it places a corresponding duty on the worker to use the respirator so provided.

Where the employer is able to establish that the circumstances in the workplace are within one of the listed exceptions and respirators are used to control the exposure of workers to lead, the employer must provide these respirators to the worker. The duty is on the employer to provide this equipment and, by inference, to pay for it. This duty is a more stringent one than that required by the Act, which only requires that the employer ensure that protective equipment is provided. The Act is silent as to who should bear the burden of paying for the particular protective equipment in question. However, in the lead regulation, the inference to

be drawn from the wording is that the cost of the respiratory equipment must be borne by the employer. The rationale for imposing the cost of respirators on the employer arises from the fact that the use of respirators as a means of controlling worker exposure to lead is an exception to the employer's responsibility to control that exposure by means of engineering controls, work practices or hygiene practices, the cost of which would naturally fall to the employer.

The regulation imposes a strict duty on the employer to ensure that no worker is exposed to lead in excess of the time-weighted average exposure levels or the maximum concentration levels. However, where those levels are exceeded because the worker fails to work in compliance with the work practices and hygiene practices required by the lead control program and where the employer has taken every precaution reasonable in the circumstances to require the worker to comply with the lead control program, the employer is provided with a defence to the contravention of the regulation.

Responsibilities of Physicians

Another feature of the lead regulation is its reliance on the medical profession. The physician has been given an important role to play in the effective implementation of a lead control program. The jurisdiction to impose any requirements on physicians flows from subsection 41(2)11 of the Act, which enables the Lieutenant Governor in Council to make regulations 'respecting the reporting by physicians and others of workers affected by any biological, chemical or physical agents or combination thereof.' Pursuant to this power, the physician is required by the regulation to report certain prescribed matters to specified individuals in those instances where the physician has examined a worker referred to him as required by a lead control program.

The most important reporting duty of the physician is found in section 16(1) of the regulation. The examining physician must give an opinion to the employer and to the worker on whether the worker is fit or, because of a condition resulting from the inhalation, ingestion or absorption of lead, is fit with limitations or unfit. In making this determination, the physician must be governed by the provisions of the Code for Medical Surveillance for Lead. Where the opinion is that the worker is fit with limitations or unfit, the physician is required to give this opinion to the employer without disclosing to the employer the records or results of the examination or tests.

The joint health and safety committee is also the recipient of part of the physician's report. It is those aspects of the report, the actual results of blood and urine tests taken under the lead control program, disclosure of which is specifically denied to the employer, which forms the substance of the report by the physician to the joint health and safety committee. In addition to the actual results, the physician must give an opinion to the joint health and safety committee on the interpretation that can be placed on those results.

When the physician concludes that a worker is fit with limitations or unfit, the physician must also advise the chief physician of the Occupational Health Medical Service of the Ministry of Labour.

Finally, the regulation purports to require the physician to maintain records of the medical examinations and clinical tests obtained as examining physician. There is a further requirement to maintain the personal exposure records of the particular worker being examined. These records must be provided to the physician by the employer. Both of these sets of records must be kept by the physician in a secure place for a prescribed period of time. The purpose for imposing this dual record keeping function on the physician is to enable the physician to properly evaluate the health of, and risk to, the worker and for all records in respect of a worker, personal and otherwise, to be retained together in the same place and for the same time period. However, should the physician be no longer able or willing to keep these records, the regulation requires the physician to forward the records to the chief physician of the Occupational Health Medical Service of the Ministry of Labour or to a physician designated by the chief physician. It is then up to the Ministry of Labour or the designated physician to maintain the records in a secure place for the required period of time.

The requirements placed on the physician to report to the employer, the joint health and safety committee and the chief physician of the Occupational Health Medical Service of the Ministry of Labour are to be performed regardless of whether the consent of the particular worker involved has been obtained. At first glance, this might appear to conflict with the physician's duty of confidentiality to his patient. This duty arises under the *Health Disciplines Act*, R.S.O. 1980, c. 196, which regulates the conduct of physicians in Ontario. Under that Act, a physician is liable to be disciplined where he engages in professional misconduct, a term which is defined in the regulations under

the Act to include the breach of confidentiality of a patient record.

However, the definition of professional misconduct goes on to provide that there is no professional misconduct where the disclosure of the record is made 'as required by law.' The lead regulation now requires the physician by law to disclose those medical records obtained by him pursuant to the regulation. A failure to do so would result in the physician being in contravention of the lead regulation. Therefore, the physician is entitled to disclose a patient's record without the patient's consent in the manner and to the parties prescribed by the lead regulation without running the risk of being disciplined for professional misconduct.

Assessment of the Fitness of Exposed Workers

One of the mandatory requirements of the lead control program is provision for medical examinations and clinical tests of workers exposed to lead. In order to ensure worker participation in the medical aspects of the lead control program, it was considered necessary to impose a positive duty on the worker to submit to the medical examinations and clinical tests required under the lead control program. The regulation makes it clear that these examinations and tests are to be carried out at the expense of the employer. However, the regulation does not state whether the choosing of the examining physician is to be made by the employer exclusively, the worker exclusively or the joint health and safety committee. This permits a degree of flexibility but, since the employer is required to pay for the examinations and tests, it would appear that the employer's agreement with the physician selected would be essential. A worker who refuses to undergo the examinations or tests will not only be in breach of the regulation, but will also need to be removed from any further exposure to lead.

The regulation specifies that the medical examinations required under the lead control program will include pre-employment and pre-placement medical examinations and periodic medical examinations and clinical tests. The contents of the medical examinations and the manner of conducting the clinical tests are detailed in two codes: the Code for the Determination of Lead in Blood and Urine and the Code for Medical Surveillance for Lead. The examining physician must conduct the examination and tests in accordance with both codes.

In those instances where the physician advises the employer that a worker is, because of a condition

resulting from the inhalation, ingestion or absorption of lead, fit with limitations or unfit, the employer is required by the regulation to act accordingly. Thus, if the physician were to advise that a worker is unfit to continue to work in a lead exposure occupation, it would be incumbent upon the employer to remove that worker from such exposure.

The regulation does not specifically address what type of compensation scheme is to be provided to workers who have been removed from exposure to lead as a result of the advice of the physician to the employer. This matter is left for the parties to determine. However, the regulation does indicate that should the worker suffer a loss of earnings as a result of such removal from exposure to lead, his entitlement to compensation is limited to that compensation to which he would be entitled under the *Workmen's Compensation Act*. The meaningfulness of this provision is limited. A regulation made under the *Occupational Health and Safety Act* could not affect a worker's entitlement to compensation under the *Workmen's Compensation Act*. However, what the provision may do is serve as a directive to the Workmen's Compensation Board indicating that a worker removed from work pursuant to a provision of the lead regulation is suffering from a potentially compensable occupational illness and the Workmen's Compensation Board should treat this fact as evidence of the worker's entitlement to compensation.

Confidentiality

The confidentiality of health information in Ontario was the subject of a recent report by Mr. Justice Krever, entitled Report of the Commission of Inquiry into the Confidentiality of Health Information. The commission examined the issue of confidentiality in detail and addressed questions arising under occupational health and safety legislation. The commission concluded that joint health and safety committees should be given access to the results of biological monitoring of workers exposed to toxic substances.

The lead regulation puts this recommendation into effect and directs the physician to disclose the results of the clinical tests to the joint health and safety committee. However, the regulation goes on to stipulate that the results are being disclosed on a confidential basis. This creates a duty upon the members of the joint health and safety committee not to disclose the results in a form from which the identity of the particular worker could be known. This duty is reinforced by the

Act, in subsection 34(1)(d) which states that 'no person shall disclose any information obtained in any medical examination, test or X-ray of a worker made or taken under this Act except in a form calculated to prevent the information from being identified with a particular person or case.'

The examining physician is required by the regulation to make certain disclosures of medical records to certain people. With the exception of these prescribed disclosures, the physician is put under a strict duty not to disclose any of the records which he is keeping, including the records of both the medical examinations and tests and the personal exposure records of the worker, to anyone other than the worker himself or the worker's physician and then only upon the request in writing of that worker. Where a worker has died, the examining physician may disclose the records of the deceased worker to either the next of kin or the personal representative of that worker, but, again, only upon the request in writing of either of those two parties. The personal representative of a deceased worker will be either his executor if he died testate or an administrator appointed by the court if he died intestate.

An important aspect of the regulation, with respect to the disclosure of confidential health records, is that it invalidates any authorization by the worker of the release by the physician of the records being maintained by the physician to any person other than the worker or the worker's personal physician. Thus, should a collective agreement purport to authorize, on behalf of all workers, the receipt by the employer of medical records, such a provision will now be invalid with respect to those medical records obtained under the lead regulation. Similarly, any provision in a contract of employment which requires, as a condition of employment, that the worker authorize the release to the employer of the results of any medical tests will also be invalid with respect to those results obtained under the lead regulation.

The Codes and Equivalency

The lead regulation itself is very brief, esssentially creating a framework within which to control the exposure of a worker to lead. Within the regulation, however, reference is made to four codes: the Code for Respiratory Equipment for Lead, the Code for Determination of Lead in Blood and Urine, the Code for Measuring Airborne Lead and the Code for Medical Surveillance for Lead. These codes are quite

detailed and add the necessary guidance to the affected parties in the four areas addressed by the codes. The legal authority for using a code to detail more specific requirements to the regulation comes from subsection 41(2)16 of the Act which allows the Lieutenant Governor in Council to make regulations 'adopting by reference, in whole or in part, with such changes as the Lieutenant Governor in Council considers necessary, any code or standard and requiring compliance with any code or standard that is adopted.' Thus, to the extent that the code has been referenced in the regulation, it becomes legally enforceable, insofar as it sets out mandatory requirements.

The codes themselves are a combination of mandatory requirements, recommended practices and descriptive materials.

It should be noted that the equivalency clause of the regulation applies to the codes. Therefore, an employer may vary from the methods and procedures required in the codes if the protection afforded to the worker or the factors of accuracy and precision are equal to or exceed those provided for in the code. The onus is on the employer to show that the variation being used is equal to or greater than that required in the applicable code. The equivalency provision of the regulation applies only to the codes and does not apply to the other aspects of the regulation itself.

Conclusion

The novel and unique concepts that form the basis of the new lead regulation are indicative of the general direction that will be taken in the future for the regulation of designated substances in Ontario. As this article has attempted to indicate, the success of the approach taken depends, in great measure, upon the existence of a knowledgeable and responsible internal responsibility system functioning effectively in the workplace. Clearly, there is also an educational challenge ahead for all concerned parties.

The new lead regulation sets the stage for the identification and control of worker exposure to lead in Ontario. Like any new regulatory initiative, the regulation will be subjected to a number of interpretations. The regulation will not answer all of the possible questions that arise. Indeed, the regulation itself may stimulate new questions. The resulting dialogue should give rise to a greater appreciation by all concerned parties of the hazards to a worker inherent in exposure to lead and the need to make a concerted effort to ensure the occupational health of workers in Ontario.

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Health Surveillance in Industry

Summary

A method that one company, Union Carbide Canada Limited, has developed for health surveillance in industry. The effectiveness of the program depends on a strong organizational structure, total company commitment, current well structured policies and co-operative co-ordinated roles. Emphasis in this paper is placed on the medical surveillance function within a complex total occupational health program.

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Health Surveillance

The practice of occupational medicine and the relationship of this science to the entire field of occupational health introduces a number of unique requirements and varied opportunities in health surveillance.

The occupational physician has responsibility in industry for the direction of a co-ordinated health surveillance medical program, with major emphasis on the role of prevention.

The elements that flow naturally from this primary objective are:

- early detection of disease process,
- recognition of health conditions related to occupation,
- identification of non-occupational health conditions,
- provision of accurate record system,
- provision of relevant statistical data available and useful for epidemiological study,
- provision for health education programs,
- provision for counselling in the workplace,
- provision of programs for correction of identified cause and effect relationship,
- provision of medical monitoring for personal protection equipment care and use.

A function of the health surveillance team is to plan relevance of program to the specifics of the workplace. The health team, to be effective, must have full knowledge and familiarity with the work process. Information of this nature includes knowledge and familiarity with plant physical design, the type and function of machines, and of maintenance function, the flow process of manufacture, the raw materials introduced, intermediates of the process and, finally, product(s) that evolve. There is, of necessity, requirement for a close working relationship and communication with safety personnel, industrial hygiene co-ordinators, employee relations department, plant management, and two-way communication with the production worker. Health surveillance at the workplace should not only

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relate to work-related problems, but it should develop a major role in identification of health conditions related to lifestyle. A well co-ordinated, efficient and thorough assessment by an experienced health team is equally as important to the worker in today's industries as the safety program, company benefits and the collective agreement.

The philosophy and practice of health surveillance in industry has caused a variety of concerns. The fact that members of the health team are employees of a company and have reporting accountabilities required by all good management systems has caused concern regarding the utilization of personal data, which are the essence of medical records. The specifics of record keeping, storage and confidentiality will be discussed later in this presentation. The assurance that the motives of the health team members are directed to the prevention of health defects is in the charter of their respective professional licensing organizations. The members of the health team are obliged to practise within the strict code of ethics of their professional college in the same manner as all health professionals practising in the community, and are subject to law, both provincial and federal. The health professional is liable for discipline for any irregularity of practice, misuse of information, breach of confidentiality or acts that constitute malpractice. The health team, in practice, must function as an unbiased third party, with primary concern for each individual and with appreciation of the position of the union, unorganized workers, and management. Enlightened union organizations and management teams must develop and maintain strong mutual social responsibility and support in occupational health programs.

Efficient health surveillance in industry will include the following elements. The method developed in our company, Union Carbide Canada Limited, will be used as the example.

A. Organization

i) Health, Safety and Environmental Affairs Committee
ii) Health and Environmental Affairs Functional Unit
iii) Plant Occupational Health Committee
iv) Plant Group Related Committee

B. Policy

i) Medical Services
ii) Occupational Health

C. Occupational Health Team

i) Physician
ii) Nurse
iii) Industrial Hygienist
iv) Safety Manager
v) Counsellor

A. Organization

i) The composition of the Health, Safety and Environmental Affairs Committee is as follows:
Vice President – link to management committee
Director, Health and Environmental Affairs
Director, Safety and Loss Prevention
Director, Human Resources
Nine General Managers

The committee is composed of the senior management of the company and expresses its accountability and responsibility for total commitment to health and safety. Responsibility in health and safety is written into every manager's measure of performance. As a result of this commitment, the maintenance of an efficient and operative system exists throughout the company.

The senior committee is responsible for the establishment of company policy and standards in occupational health.

ii) The Health and Environmental Affairs Department performs a staff organizing, co-ordinating and designated service role for consistent operations of the programs. Program audit is an essential element of the department's function. The roles of the Health and Environmental Affairs staff are as follows:

Director
- provides effective company medical services
- provides occupational health programs
- co-ordinates environmental affairs

Manager, Occupational Health
- develops occupational health programs
- develops priority of plant OH risks
- co-ordinates programs
- provides service and advice

Manager, Environment
- provides external environmental programs

iii) The Plant Occupational Health Committee addresses the specific programs and procedures at the operating level to achieve the full effectiveness of an occupational health program. The composition of the committee ensures that all lines of communication are established and that each discipline will fulfill its function within the total program. The membership of this committee is:
Plant Manager or Delegate
Plant Industrial Hygiene Co-ordinator
Plant Safety Co-ordinator
Plant Employee Relations Manager
Company Manager, Occupational Health
Director, Health and Environmental Affairs
Plant Nurse
Plant Contract Physician

iv) The Plant Group Related Committee. At regular meetings of this committee, a two-way flow of communication is established to convey actual health program results and industrial hygiene monitoring specifics to the production worker and to receive a reciprocal flow of comment and recommendations for future programs and to establish priority of attention to the health and industrial hygiene requirements. The membership of this committee generally is:
Plant Manager or Delegate
Plant Industrial Hygiene Co-ordinator
Plant Union Steward
Plant Worker Reps.

B. Policy

For the purpose of this presentation, remarks will be limited to the structure of the policy on occupational health. A well structured policy, in a few words, will allow for the development of complex programs and procedures that are appropriate to the specific operating location. The components of a good policy are:

Policy Statement
- a concise statement of purpose.

Minimum Standards
- understandable
- achievable
- realistic

Accountabilities
- description of responsibilities to ensure achievement of purpose and standards.

The Union Carbide Canada Limited policies on occupational health and medical services are contained in Appendix 1 and Appendix 2 respectively.

C. The Occupational Health Team

The component disciplines were outlined under program design. Efficient performance of the team depends on close co-operation between members of the health team and maintenance of credibility at the work site. Effective manuals for medical, nursing, counselling and education procedures must be developed and consistent procedures implemented.

There are few full-time on-site occupational health physicians in Canada. The day-to-day efficiency of many manufacturing locations depends on implementation of programs and organization within the medical department by the occupational health nurse. The Ontario Occupational Health Nurses' Association provides an excellent resource for OH nurse training and program development. The nurse, contrary to previous assignment within industry, must have his or her full responsibilities and accountabilities directed to the plant health program and not diluted by miscellaneous duties. The ultimate responsibility for confidentiality of records, responsible record keeping, proper scheduling of required tests and examinations, health education, and co-ordination of industrial hygiene exposure reports to specific biological medical requirements belongs to the occupational health nurse.

The occupational health nurse carries on one dependent function: the provision of definitive care to workers who are injured or ill, legally and ethically as a nurse when he or she works with a physician who provides medical directives as the basis for treatments provided.[1]

The role of the industrial hygienist may be defined as that science (or art) devoted to the recognition, evalua-

tion and control of those environmental hazards – chemical, physical, biological and ergonomic – that may cause sickness, impaired health or significant discomfort to employees or residents of the community.[2]

This role is closely tied to the medical function by representation on the Occupational Health Committee, preparation of job related exposures through job classification form and by regular health team meetings and communication. The industries that are smaller and that do not have regular accessibility to industrial hygiene monitoring can obtain this advice from the Occupational Health Branch of the Ministry of Labour. There are also private organizations offering consultant services in occupational health.

Co-operation and regular review of safety practices within the plant with the safety co-ordinator is of prime importance to the health team. This is a subject that requires discussion under a separate presentation as it is a most relevant health team related function.

The other health disciplines that are appearing in the health surveillance teams are counselling and ergonomics. The latter is a science most relevant to modern day industry.

The ultimate success or failure of any organization is determined by how well its manpower talents and resources are utilized. In the sphere of occupational safety and health, talents that have existed for many years often have been suppressed because of outdated theories regarding safety, medical and occupational health disciplines.

Medical Assessment

Program elements in medical surveillance require specific procedures and detail of content. They are:

i) Pre-placement Examination
   a) Pre-employment
   b) Job Change

ii) Routine periodic assessment
   a) Voluntary Health Maintenance
   b) Special Requirement
      i.e. Driver Examination
   c) Toxic Substance Exposure
      i) Company Policy
      ii) Legal Requirement

iii) Record-Keeping.

iv) Examination on Return to Work Following Injury or Illness.

v) Exit Examination.

i) Pre-employment or Pre-placement Examination

The pre-employment examination establishes the baseline health data on entry to the workplace, the data from which to measure any variation in health, either positive or negative. The data may then reveal a future common problem arising from one area or one process of the workplace and fulfill the function of recognition and prevention as a prime requirement of the health team. The new employee is also made aware of the presence of the health team and the services available. Initial educational material on the workplace is provided. There are rare exceptions where job description and applicant health defects do not blend.

Communication of results of examination to the appropriate department is done by simple form and without disclosure of diagnostic or confidential information.

The component parts of a pre-placement examination are:

1. History
   a) Detail of Previous Workplace Exposure
      i) Exposure Hazards — Toxic — Physical — Chemical — Duration of exposure
      ii) Accident History
      iii) WCB History

   b) Family History
      i) Hereditary Trends

   c) Medical History
      i) Medical
      ii) Surgical
      iii) Treatment
      iv) System Enquiry

2. General Physical Examination
Full System Assessment

3. Laboratory Procedures
Haematology
Biochemistry — SMA12 or equivalent
Urinalysis

Chest X-ray or I/C test — at physician's discretion
Visual test
Audiometric test
ECG
Special — (i.e. — Spirometry)

ii) Periodic Health Examination

Periodic health evaluations are traditionally justified for the following reasons:

1. Early detection and treatment of potentially dangerous disease.
2. Identification of risk factors.
3. Prolongation of life through risk factor modification or early treatment.

Industry has a number of special justifications for periodic examination.

Medical surveillance examinations in industry are required for workers exposed to certain toxic chemicals or physical stresses. They are necessary to detect the earliest possible adverse effects of such exposures and to provide an opportunity for communication regarding work environment problems. Finding out what problems workers are having, answering their questions factually, educating them on prudent work practices, informing them of their exposures and reassuring them by candid discussion are some important side benefits of periodic examinations.

The periodic health evaluation should provide an opportunity to ask questions and seek advice on both work and non-work related health problems. Time spent on responding to such needs is justified on an educational and employee relations basis. A rapid, cursory examination with little opportunity for developing a medical history is of little value. Not infrequently, work related problems are uncovered almost accidentally by a carefully solicited history. If done well, it is probably here, more than in any other justification, that the company shows its interest and sincerity in employee health.

Risk factor intervention may appreciably improve the quality of life even though the length of life may not be increased. People who are successful in modifying harmful health practices usually derive impressive benefits.

During the periodic health evaluation process, much valuable health experience information can be accumulated. Although most epidemiological studies are

presently based on reviews of mortality, rather than morbidity rates, having accurate health experience information is of value to the worker and provides data for correction of health hazards within the workplace. Epidemiology depends on accurate data supplied from professional sources using scientific methods to establish deviation of health from the experience of other working populations or the population in general.

Sudden temporary incapacitation or gradual deterioration of sensory faculties, alertness or agility can cause injuries to workers. The potential for these problems can often be detected during a careful examination and appropriate restrictions applied. Workers exposed to chemicals that have a potential for liver toxicity should be especially carefully monitored for drugs that impair or alter liver function. Alcohol is related to more deaths among young adults than any other single factor. It is responsible for 50 per cent of the deaths from motor vehicle accidents, 60 per cent from drownings, 75 per cent from fires, 85 per cent from cirrhosis and most of the primary cancers of the liver, esophagus, mouth and pharynx. In addition, it is responsible for many on-the-job accidents.

People in excellent health with few or no risk factors and no exposure to toxic materials certainly need to be examined less frequently than those with multiple risk factors. As risk factors for more degenerative diseases are defined by epidemiological and other research studies, the scheduling process will become complex, but, when defined, make the process more effective.

The subjects of medical examination, record-keeping and confidentiality as prescribed by law, and regarded as necessary for good occupational health surveillance by the health team, may be considered by reviewing the proposed regulations for designated substances under the *Occupational Health and Safety Act*. The major issues from the Act and from the regulations state that a control program shall include provisions for:

(a) Engineering controls and work practices
(b) Monitoring of the workplace
(c) Maintenance of personal exposure records
(d) Pre-placement and periodic medical examinations and tests
(e) Records of medical examinations and tests to be maintained

A routine, scientific, organized specific assessment at regular intervals is more practical for the worker and certainly is necessary for any productive assessment of health related trends and for viable epidemiological assessment. There is also provision in that Act that when biological monitoring indicates exposure of an individual beyond recognized safe limits, the person be removed from the workplace until normal biological levels are achieved, i.e. blood lead in excess of 70 ug/100 ml. This, in turn, requires repeated tests until the designated minimum level or lower are achieved. A worker not consenting to such tests could suffer serious permanent health defects.

The records that must be maintained in a confidential file for use by the health team are:

1. Pre-placement medical exam, to include information already appended.
2. Health maintenance exam
   (a) voluntary
   (b) legal exam requirement
3. Specific examination as designated by substance under the *Occupational Health and Safety Act.*
4. Job classification form.
5. Workplace exposure time record, an example of which is shown in the accompanying table. A major problem exists in particular relationship to maintenance personnel.
6. Workplace industrial hygiene monitoring results.
7. File on repeat scheduling of required examination.
8. WCB records.
9. Non-occupational illness.
10. Referral and consultant records.
11. Return to work following illness assessment.
12. Specific conditions that make certain work practices hazardous to the worker's health.
    i.e. cardiac restrictions
    allergic reactions
    restrictions on respirator utilization

Exposure Summary Form

Dept. #11

Job and/or Area Classification: Cast Operator
Number of Operators: 1 per shift

Hazards & Areas	Exposure Time	No. of Samples	Mean Exposure	TWA Exposure	TLV	Range	Comments
Zinc	100%	4	0.78 mg/m³	0.78 mg/m³	5 mg/m³	0.75-1.11 mg/m³	Operator exposure below the TLV.
—Fumes from the melt pot.							STEL is not exceeded.
Cadmium	100%	4	0.003 mg/m³	0.003 mg/m³	0.05 mg/m³	0.003 mg/m³	Operator exposure below the TLV.
—Fumes from the melt pot.							STEL is not exceeded.
Graphite	100%	4	1.72 mg/m³	1.72 mg/m³	10 mg/m³	1.13-2.61 mg/m³	Operator exposure below the TLV.
—From the tumblers.							STEL is not exceeded.
Noise	100%	—	—	Over	90 dBA	92-106 dBA	Operator exposure above the permissible limits.
—From the tumblers and casting machines							Operator is required to wear hearing protection and is required to undergo annual audiometric examination.
—General area noise							

The health records of an individual must be maintained in a confidential file with access available only to the physician or nurse. The manufacturing locations that have off-site medical consultants must ensure that records are maintained in a similar confidential file in the physician's office. There is a final stipulation by regulation that, where required, records can no longer be retained by the physician or employer, that they may be stored by the chief physician of the Occupational Health Medical Service of the ministry. Union Carbide maintains medical records from small locations in a central confidential file in the medical department at head office.

The law also stipulates that medical records of a worker and personal exposure records shall be made available to the worker or his authorized agent. In all instances, requests for personal confidential information must be accompanied by a signed and witnessed release form.

There are instances in medical practice in occupational medicine where information of the health of an individual, for purposes of his own protection and/or

the safety of others, must be shared with persons outside the confines of the medical department. This intent can be fulfilled by a simple statement of fitness or unfitness and advice generally confined to the ability or limitation of function. Discussion on further courses of action should be directed to the best possible alternatives and involve the individual in all stages of planning for job alteration.

The health team in modern society is also developing a major role in general health maintenance, assessment of health hazard appraisals related to lifestyle, development of information sources on subjects such as diabetes, hypertension, health in retirement as well as the attention to fitness programs and development of counselling in the workplace.

There is, with modern day technology, a requirement for policies, programs and procedures to be implemented in consideration of new scientific information. The health surveillance team must ensure that effort is directed toward the recognition of exposure hazards that may have properties of being carcinogenic, mutagenic and teratogenic. The basic guide developed by Union Carbide has a policy entitled 'Embryo-Fetus-Protection'. The policy statement is to implement practices that ensure the protection of all female employees of child-bearing capacity from occupational health risks that may produce fetal abnormalities. Female employees are requested to report pregnancy to the medical department where possible risk is involved. Risk factors are explained and appropriate job change is made in keeping with good labour relations and the collective agreement. A list of possible risk chemicals is maintained by the Health and Environmental Affairs Department and circulated to plant locations every six months. In addition, new programs in consideration of male genetic exposure are being established.

Communication of exposure risks to the worker population is best achieved by discussion at the plant group related committee meetings. An additional source of information that is an effective way of fulfilling this commitment is utilization of material safety data sheets available at the supervisor's location on the plant floor and appropriate to the materials in use at the specific area of manufacture. Material safety data sheets are maintained current by review every two years and a central file of all UCCL sheets is being established in the head office location. The medical department must also be prepared to discuss work related exposures with the workforce.

Additional attention of the health team is directed to hearing conservation and noise control. The most effective method of monitoring audiometric test results is by computer. This readily identifies shifts in hearing, thus identifying possible noise sensitive employees or areas where additional monitoring and engineering control may be necessary. The audiometric test program is a major function of the occupational health nurse, and in manufacturing locations the nurse has the responsibility of performing tests, scheduling repeat evaluation, identifying occupational and non-occupational hearing defects and arranging referrals and co-ordination of the program with the industrial hygiene co-ordinator. The selection and care of appropriate personal protective equipment, along with an educational program, is of prime importance in this health area.

Health team concerns are also directed to immunization schedules, advice to employees on foreign travel and compliance of on-site contractors with company occupational health and safety requirements and policies.

This presentation has touched on the great number of responsibilities in health surveillance. There is, in addition, the day-to-day responsibilities of care and treatment of the workforce, which is a major function of a well organized department.

Acknowledgements

Union Carbide Canada Limited Basic Policy Guide for Health, Safety and Environmental Affairs Manual.

Presentation by Dr. T.C. Lincoln — Corporate Medical Director, Union Carbide Corporation, delivered to the O.M.A. section conference September 17, 1981 in Toronto.

Presentation by Dr. Margaret Kerr, Medical Director, Shell Canada Limited, delivered to the Occupational Health Physician Academy of Medicine, Toronto, October 1981.

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[1]Zenz Carl, 1975 Occupational Medicine Principles and Practical Applications Year Book. Med Pub Inc. Chicago: 1975: 3:43.

[2]*Ibid.*

Appendix 1

Union Carbide Canada Limited

Occupational Health Policy

Occupational Health

Programs and procedures are developed, introduced and maintained at all company locations to ensure maximum practical protection to the health of the employees. These will include compliance with all applicable laws and regulations, reduction or elimination of health hazards and prevention of occupational illnesses.

Standards

1. Employee Protection
Occupational health risks are identified and programs for protection are developed.

2. Exposure Levels
Exposure levels comply with governmental standards or UCCL mandated levels.

3. Employee Communication
Union Carbide will advise employees of identified occupational health risks and protective programs.

4. Hearing Conservation and Noise Control
A hearing conservation and noise control program to protect employees against occupational hearing loss is implemented.

5. Embryo-Fetus Protection
Practices and procedures are developed to provide protection for the embryo-fetus from exposure to risks that may have adverse effects on a developing embryo-fetus.

6. Contractor Off-site
Occupational health practices of contractor off-site are acceptable to UCCL and comply with government requirements.

7. New Products, Process Materials and Purchased Process Materials
New products, process materials and purchased process materials will be reviewed for all occupational health concerns.

8. Respiratory Protection
Respiratory protection devices will be used to provide adequate protection to employees during work operations and emergency conditions of work where other protective measures are not adequate or feasible.

9. New Facilities
New facilities and major expansions will meet governmental regulations in occupational health.

10. Material Safety Data Sheet
Union Carbide will provide consistent, uniform and adequate health, safety and environmental information about its products, process materials and purchased process materials.

11. Occupational Health Audits
A system of audits is established and audits of occupational health programs and procedures are conducted periodically to assure compliance with standards and objectives of this manual. Conclusions, results and action plans resulting from each level of audit are reviewed during the audits by the next level or levels of accountability.

Accountability:

1. Each business and functional unit will have line accountability to ensure that occupational health standards are met.

2. The director of health and environmental affairs is accountable for monitoring and reporting on the implementation of this policy throughout the company. The director, as co-ordinator, and any co-ordinatee have the right to escalate any conflicts.

3. Proposed legislation applicable to occupational health is monitored by the Health and Environmental Affairs Department. Where necessary and appropriate, the company position is made known to the government through the director of health and environmental affairs or other manager designated by the management committee.

Appendix 2

Union Carbide Canada Limited Medical Services Policy

Medical Services Policy

Union Carbide Canada Limited will provide medical services and programs to employees to support good occupational health, medical and safety practices. The objective is protection of all employees from the effects of physical and emotional hazards of the workplace.

Standards

1. Personnel
Professional medical personnel are selected to provide essential medical services.

2. Pre-Placement Examination
Pre-placement examination will be completed to assess emotional and physical capabilities of a prospective employee in relationship to health, safety and exposure hazards of the workplace.

3. Routine Medical Examination
A medical surveillance program will exist for Union Carbide Canada Limited employees.

4. Special Medical Examination
The company will provide special occupational medical examinations for purposes of health maintenance and protection of employees.

5. Medical Care
Medical care will be provided for illness or injury.

6. Rehabilitation
Medical personnel will provide instruction and assistance in considerate rehabilitation of the employee returning to the workplace following occupational or non-occupational illness or accident.

7. Education
Health educational programs are prepared and presented.

8. Records
Adequate and complete medical records are maintained; legal requirements of confidentiality are met.

9. Alcoholism
It is the policy of the company to recognize alcoholism as a disease, to relate continued employment to corrective action, to provide appropriate support for rehabilitation.

10. Foreign Travel
Medical clearance will be obtained for foreign travel.

Accountability:

1. Each business and functional unit will have line accountability to ensure that standards set by this policy are achieved.

2. The director of Health and Environmental Affairs is accountable for monitoring and reporting on the implementation of this policy throughout the company. The director, as co-ordinator, and any co-ordinatee have the right to escalate any conflicts.

3. Occupational health committees are formed by each business and functional unit to develop reliable preventive programs to achieve compliance with company policy.

4. Proposed legislation applicable to this policy is monitored by the Health and Environmental Affairs Department. Where necessary and appropriate, the company's position is made known to government through the director of Health and Environmental Affairs or other manager designated by the management committee. Participation in government committees or associated task groups is encouraged.

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Problems and Approaches to Shift Work

Summary

This paper reviews the health and performance effects of shift work and details strategies for reducing some of the difficulties. Awareness of the difficulties that certain shift rotations present to the employee should motivate the employer to re-assess the schedule of rotation that is in use.

During the last 50 years, the use of shift work has increased extensively. The introduction of continuous production processes and the large capital expenditure for equipment has compelled employers to use workers around the clock. The natural 'circadian rhythms' (daily bodily cycles) appear to be one of the major contributors to the problems that many people have in adjusting to shift work. A person's physical and social environment provides numerous time cues (Zeitgebers), which act to influence the rhythms of different body systems. The general pattern of a rhythm is the same for individuals exposed to the same Zeitgebers, but the magnitudes of the rhythms may be different. Examples of some commonly studied rhythms are sleep schedule, temperature, resting heart rate, blood pressure and hormone secretion.

Shift Work: Disturbing Normal Circadian Patterns

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Sleep

The most common complaint of individuals about shift work is that sleep duration and quality are poor during the schedule of night shift. Individuals on night shift average about five to six hours of sleep compared to eight hours for day workers.[1,2] Night shift workers take more of their sleep time in the form of naps, and they sleep more on the weekends after a rotation of night shifts than after other shifts.[3] Also, the difficulties of obtaining adequate sleep appear to become greater as shift workers get older.[4] Daytime noise is often blamed for the poor sleep of shift workers but Weitzman and Pollock[5] have shown that individuals experience a decreased ability to sleep during the day, even in a quiet environment. Timing of the sleep-wake cycle appears to be just as important as the total amount of sleep. The unrefreshed and listless feeling after even a long sleep may be due to lowered adrenal hormone levels, which occur when customary sleep time is reversed.[6]

Diet

Shift work has also been blamed for disturbing appetite and normal eating patterns. The irregular sleep and activity patterns make it difficult to follow the same eating habits as during normal day work. Debry *et al* in a case study found that shift workers ate more animal protein and drank more liquids (including alcohol) than day workers.[7] Total caloric intake is not affected by shift working, but the distribution of intake is changed over the 24-hour period.[8] Night workers also tend to increase their intake of caffeine and indulge in heavy tobacco smoking in order to increase their wakefulness during the work shift.[9] This dietary pattern often aggravates gastro-intestinal problems of the individuals, as will be elaborated on later.

Health Effects

Aggravations of normal patterns of sleeping and eating by shift work have caused some people to suspect that an individual's health may be affected. This topic has received attention from numerous investigators, but, unfortunately, there are few definitive answers. Many studies tend to use existing employee populations' subjective assessments of health and absence records as indicators of health. The findings of most of these studies can be discredited for the following reasons.[10] Existing populations of employees are biased by the self-selecting out by individuals from a certain work routine, and 'sickness absence' records should more appropriately be named 'absence from work attributed to sickness.' It is widely recognized that sickness absence is not a reliable indicator of true morbidity and that it is influenced by many factors that have nothing to do with health or disease.

1 Mortality

Taylor and Pocock[11] analysed 1,578 deaths of 8,603 male manual workers and found that there was no difference in the death rate for all causes between day workers and shift workers. There was some evidence of an excess of neoplastic deaths in shift workers, and bronchitic deaths in day workers. Shift workers are frequently a selected population, since people drop out when they have difficulties in adapting. It may be expected that such a population of workers would have a lower death rate than day workers.

2 Morbidity

Some investigators have identified gastro-intestinal complaints associated with shifting work schedules.[10,12,13] Dirken,[14] in a study of shift workers, could not find any excess of gastro-intestinal problems. Thiis-Evensen's[15] investigation of 3,058 workers found that shift workers had twice as high a rate of fully developed ulcers as day workers. Former shift workers had the highest frequency of ulcers of any group. The pattern of ex-shift workers having the greatest number of complaints is found repeatedly. This group has self-selected itself out, and may reach as high as 20 per cent of all individuals who start shift work.[10] They continue to have problems even after they change to day work, which suggests that something more than just rotating work schedules affects them.

In studying an employee population, Anderson[4] found that 72 per cent of day workers with symptoms of stomach disorders had consulted a doctor, while only 47 per cent of shift workers had. He interpreted this as evidence that shift workers experience their symptoms as nothing but unpleasant side effects to their jobs, whereas day workers experience them as symptoms of suffering, which require treatment. The research findings in this area are inconsistent. However, Harrington[10] summarizes the present state of research best when he writes:

'there is some epidemiological evidence which suggests that rotating shift work may play a part in either causing gastro-duodenal ulceration or at least exacerbating latent or pre-existent overt disease. More-over shift work is not conducive to good ulcer management with its irregular hours and disordered meal times.'

3 Individuals at Risk

The research on health effects of shifting schedules is not definitive, but the literature does indicate that certain existing health problems may prevent an individual from becoming involved or remaining in shift work. A disturbance, caused by shift work, of the circadian fluctuation of sensitive physiologic systems may make a person with the conditions of diabetes mellitus, epilepsy, respiratory-cardiovascular and renal disorders more vulnerable to a sudden emergency.[16] (Unfortunately, no controlled shift work studies of individuals with these health problems are available, so Winget's[16] conclusions appear to be based upon inferences from the literature on these diseases.)

Effects on Work Tasks

Shift work has also been implicated in influencing human performance, work output and occupational accidents. Results and conclusions of many research studies are in disagreement over the effects of shift work on these parameters. Research design weaknesses in many studies limit their value. One of the most serious problems is that there is very little control over whether the working conditions on the different shifts are the same.[10] The failure to assess 'near misses' as well as overt accidents also provides possibilities for bias.[17]

1 Performance

Browne[18], in a study of switchboard operators, noted that the least delay in responding to a call occurred on the 1600 to 2300 hours shift and the longest delays were on the 2300 to 0800 hours shift. Work load during the day did not affect performance and, indeed, at night, it seemed to improve it. Bjerner *et al*[19] were able to study work performance outside of the lab and still keep work conditions the same irrespective of time of day. In studying 115,000 gas meter readings made over a period of 20 years, they found that error rates were greatest at 0300 hours and 1500 hours. No relationship to weekday or season was found. Hildebrandt[20] found that errors by engine drivers also peaked at these times. The largest peak of errors occurred in the early afternoon, while a second peak of errors occurred at 0300 hours. He observed that the peaks were more noticeable in those individuals that were reaching these times late in their shift. The implication made by Hildebrandt is that at least two factors may be contributing to the errors. Both the time of day and the fatigue of the drivers in relation to their duty hours are important determinants of performance.

Hale[21] has shown that individuals fatigued by sleep loss can maintain pre-sleep loss levels of performance. There is, however, a significant increase in expenditure of biochemical, physiological and behavioural resources to maintain that level. Wojtczak-Jaroszowa *et al*[22] found that length of time on a shift superimposed an effect on performance beyond that of circadian variations. This supports the findings of Hildebrandt[20] and raises the question of how much can individual motivation affect performance? The work of Glenville *et al*[23] also suggests that motivation can offset shift work effects on performance. They found that computer operators' reaction time actually improved on the first

day of night shift. This occurred on the initial testing, but disappeared as the study was extended. As suggested within this paper, once the novelty of testing wore off, the effects of shift work demonstrated themselves.

Folkard and Monk[24] conclude that performance efficiency on a night shift seems to depend primarily on three factors; (1) the demands of the task, (2) the type of shift system and (3) individual differences between shift workers in the degree to which their rhythms adjust to night work. Memory or storage demands of the task will influence performance in two ways. First, storage load will affect the phase of the normal performance rhythm and, secondly, it will influence the rate at which the rhythm adjusts to night work. The rate of adjustment will also be influenced by the shift system; permanent systems resulting in greater overall adjustment than either weekly or rapidly rotating systems. The rate of adjustment of performance rhythms will vary between individuals.

2 Output

What does the effect on mental efficiency of night work mean in terms of factory output? In the usual factory situation there is no evidence that output is substantially less on the night shift.[3] The pioneering work of the Health of Munitions Workers Committee[25] examined output of different shifts and found it to be about the same or only slightly less on the night shift. Similarly, Wyatt and Marriott[26] found that the night shift had slightly less output (approx. 5 per cent). However, both studies demonstrated that as the length of rotation of night work increased, output was adversely affected. The workers accumulated fatigue over the successive days. The first week of returning to day work was associated with lowered output, but subsequent weeks were associated with increased output. This suggests that these individuals were recovering from the fatigue of night work.

Consensus of opinion among researchers suggests that there is no, or only a slight, difference in output between day and night work. Browne[18], however, points out the difficulty in making this conclusion. He notes the problem of comparing two factory conditions that differ on a wide number of dimensions. In comparing the efficiency of day workers and night workers 'like' is not being compared with 'like.' Browne states

that the variety of material factors affecting factory output usually overwhelms any physiological changes in performance.

3 Accidents

Menzel,[27] in a review of shift work and accidents, reports studies that show an increase of accidents on night work and other studies that demonstrate no such increase. Andlauer and Fourre[28] demonstrate one of the difficulties in studying the question of accidents and night work. They found that there were fewer accidents on the night shift than the other two shifts, but on further analysis discovered that the accidents were more serious. This is supported by the work of Wyatt and Marriott,[26] who point out that for minor injuries, men are less likely to go to the first aid station at night. The reviewed research is inconclusive and does not answer the question whether night work is associated with more accidents. The studies that have been done suggest that any relationship that might exist cannot be very definite otherwise one could expect to see a large difference in number of injuries between different shifts. The difficulty in determining if a relationship exists between shift work and accidents is that conditions are not the same between different shifts.

Reducing Difficulties of Shift Work

Shift work has become an integral part of modern industrialized society where as many as 20 to 25 per cent of all workers are involved in it.[10] Clearly, shift work will not be abolished because some people feel it is socially undesirable or that it may be hazardous to the health of certain individuals. The fact that as many as 20 per cent of individuals who start shift work cannot tolerate it and that it is a direct cause of discomfort for many people requires that more research be done to determine how to decrease the negative effects of shift working. Research that has been done to date provides some suggestions for making shift work more acceptable to those involved. There are basically two strategies for reducing the impact. One approach is to devise schedules of rotation designed for the tasks required. Where this is not possible, the proper selection of individuals who easily adapt to shifting schedules should reduce the problems.

Scheduling

Management frequently gives less consideration to the implications of introducing a specific shift work schedule than it should. The features of circadian rhythms make the following considerations very important.

1 Starting and Finishing Times

Kleitman[29] has proposed that 0400-1200-2000 hours starting times should be used as the standard for a three shift rotation system as this conforms to the body temperature cycles of workers. This suggestion is supported by Bjerner *et al*,[30] who found that workers on continuous alternating shifts starting at the hours 0400-1200-2000 slept more than after a change to 0600-1400-2200 hours. However, the 0400-1200-2000 hours schedule could make it difficult for individuals reporting to work on the morning shift. Walker[3] feels that a high percentage of morning absence occurs because of a starting time of 0600 hours. If individuals have far to travel, it may be worse with a starting time of 0400 hours. Many firms now work shifts of 0700-1500-2300 hours. This schedule has the disadvantage that the morning shift individuals are at a low in the circadian performance rhythm (1500 hours), just when they have accumulated fatigue from an entire shift. In occupations where an error has severe consequences, shifts that are coming to an end during a low in the normal performance rhythm should not be used. Walker[3] suggests that managers should be flexible in their approach to starting and stopping times and willing to be more imaginative in selection of time schedules. The above considerations should be kept in mind when choosing such a schedule.

2 Order of Rotation

The order in which the shift schedule is changed affects the speed of adaptation. This effect was first realized when it was observed that an individual adjusted more quickly to a westward flight than an eastward flight. An example of a schedule of rotation that should be used so that a person may adjust more quickly is that of mornings to afternoons to nights. If, on the other hand, a slower speed of adaptation is desired, the order of rotation should be nights to afternoons to mornings. The order of rotation also has the effect of varying the length of free time on days off, which could make one

system more favourable to the employees. For example, days off after night work requires the person to sleep during the daytime on the first day and also requires that he be prepared to start early in the day upon return to work. This has the effect of reducing the useful time off. The information on shift work is becoming clear that no one system is the best and that any system should allow workers some flexibility within it. Requirements of the job should be used to make some assessment of a particular schedule's value.

3 Length of Rotation Period

Fixed shifts or slow rotation are only effective in overcoming circadian disturbances if the employee does not revert to a daytime schedule on weekends or days off. Any entrainment (adaptation) that has occurred during the week will be lost on the weekend.[10] For the majority of individuals, the restrictions on social and family life that this causes would not be tolerable.[13] However, for some individuals, the system may be ideal.

Systems of weekly rotation are the most common, but they are not the most advantageous for an individual's circadian system. The rhythms cannot adapt in less than seven consecutive night shifts.[31] The individual accumulates fatigue in the early part of the schedule due to the lack of restful sleep[32] and just as he is starting to adapt, he is switched again. This schedule places the person in the position of constantly being in a state of transition with the night shift period, placing the greatest physiologic costs on the individual. The system does have the advantage that an individual is not socially isolated from his family and friends for long periods at a time.

Rapidly rotating schedules are being used to minimize the accumulated fatigue that occurs with working many successive night shifts.[33] These systems involve working a shift for two or three days and then switching to another shift. A typical rotation would involve 2 mornings, 2 afternoons, 2 nights and then 2 days off. This is too short a period for any entrainment to occur[34] and there would not be any re-entrainment required when a switch is made. Mills *et al*[35] state that there is a danger that an individual's circadian rhythms may become desynchronized unless there is a sufficiently strong Zeitgeber with a regular 24-hour period. They suggest that the possible Zeitgebers need investigation; however, a regular sleep from midnight to 0400 hours may be adequate, even if subjects take the remainder of their sleep at irregular

hours. This could certainly be accomplished with the exception of the few night shifts. Knauth *et al*[32] have proposed a systematic method for selection of shift systems with the aid of work physiologic criteria. They feel that work times should not exceed eight hours, the number of consecutive nights must be limited and night shifts must be followed by at least 24 hours of free time. Workers experience greater fatigue and performance decrement if shifts are longer than eight hours.[36,37] Social requirements are that each shift plan should contain free weekends, with at least two consecutive free days and that the number of free days per year be at least as great as for constant day workers.

Walker[3] states that workers respond favourably to rapidly rotating schedules because they provide some days each week when they have free time during normal hours. This allows them an opportunity to have some social activity with family and friends. Management's fears of difficulties in administration of rapid rotation were not realized. They actually found it easier to keep in touch with shift workers, and supervisors found it much easier to maintain more frequent contacts with shop stewards. Some negative effects of the rapid rotation were that workers' consecutive days off were reduced and an initial investigation by Pocock *et al*[38] suggests that certified and uncertified sickness absences increased in the year after the change. Given some data collection problems, it is important that this study be repeated on a larger scale.[3]

Worker Selection

Research has shown that some individuals tolerate or adapt to shift work more easily than others. Techniques that could be used to identify these easy adapters would be of great value in reducing the burden that shift work places on employees. This objective is the focus of a great deal of research, but to date no precise techniques have been found. Research has established some characteristics that correlate with easier adaptation and these could be considerations for selecting individuals for certain jobs or schedules of rotation.

The most immediate selection procedure should be to replace rotation with permanent night work for those individuals who volunteer to stay on permanent nights. Some individuals prefer permanent nights and the introduction of this option in scheduling would allow a

reduction in the number of remaining positions that would have to be filled with rotating workers.

Workers with diseases that could be exacerbated by shift work should be discouraged from going on rotating shift schedules.[10] Examples of such diseases are insulin dependent diabetes, epilepsy and severe coronary heart disease. If individuals with these diseases are included in shift work, they should be monitored closely to assess the impact on their health.

An individual's circadian pattern does have unique characteristics that may have an influence on whether or not the person is a good candidate for shift work.[39] As well, it may indicate that one schedule is inappropriate for that individual while another is acceptable. Reinberg[40] has found that individuals with large amplitudes in circadian temperature rhythm are more tolerant of rapidly rotating shift work and show slow rates of entrainment to night shifts. Slow adaptation would be an advantage because there is no need for re-adaptation when the shift changes. The opposite may be true for a work situation that involves slow rotation and where the individuals do not revert to daytime scheduling on weekends. It would be advantageous to adjust quickly under these circumstances. Aschoff[41] has shown that a fast adjustment to a phase shift of Zeitgebers appears to be associated with a relatively small amplitude of circadian rhythm for certain variables (oral tempeature, urinary 17-OHCS and peak expiratory flow). These individuals would have a reduced number of days of imbalance and as long as they do not revert on weekends they would be able to adapt to the shifted schedule more quickly.

Researchers have recently begun to explore the relationship that certain personality traits have with adaptability to shift work. These specific traits could then be used to identify the individuals who would be best suited to cope with shifting schedules.[42] Aanonsen[43] was one of the first researchers to identify that a high proportion of workers who transferred to non-shift work for medical reasons were of the type 'early to bed – early to rise.' Ostberg[44] found that individuals who were scored as 'morning' types had the greatest difficulty of adaptation to night work while the 'evening' types found night work no more difficult than day work. Both groups found the evening (afternoon) shift the easiest in the weekly rotation schedule. Horne *et al*[45] found that correct rejections on an inspection line task were greater in the morning for 'morning' types and greater in the evening for 'evening' types. 'Evening' types showed a steady improvement through-

out the day while 'morning' types showed the reverse trend. Blake[46] reported similar differences in performance between introverted and extroverted individuals. The introvert demonstrates characteristics that are similar to the 'morning' individual. The personality trait of neuroticism has also received some research attention. Lund[47] has indicated that individuals with high neuroticism scores show a greater tendency for 'internal desynchronization' under conditions without Zeitgebers than 'stable' subjects. He states that the disadvantages of shift work can be expected to be particularly marked for people with high neuroticism scores.[48]

Conclusion

Deciding on an appropriate shift schedule or an individual to do the work are important approaches to minimizing the impact of shift work. Harrington[10] describes them as considerations for the needs of the job and for the well-being of the worker and his family. Unfortunately, research in this area is still at its early stages and the suggestions listed are preliminary indications of worthwhile directions to explore. There is a clear need for the development of appropriate models for studying the effects of shift work on the circadian variation of physiological functions. Also, much more effort to identify the Zeitgebers which are most crucial for adaptation to a time shift is needed. Such information may be obtained from the results of experiments on

a) shift work conducted in the laboratory,
b) shift work conducted in the field and
c) the effects of repeated phase shifting.

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Hydrogen Sulphide Poisoning

Summary

This paper recounts the finding of four dead waste water workers in a septic tank complex, details the subsequent investigations reconstructing the incident and discusses hydrogen sulphide poisoning.

Maintenance work on waste disposal complexes large or small is often unpleasant and usually hazardous. Wide-ranging chemical and microbiological risks from specific wastes may be amplified because exposure occurs within confined spaces of the complex. Not only does confined space work have the effect of concentrating existing hazards, it also provides potential for new physical risks and ergonomic problems. Unfortunately, appropriate precautions for working in confined spaces[1,2] are sometimes ignored, with unhappy results.

Case Report

A liquid-waste disposal company was engaged to clean out a 32,000 gallon underground septic tank complex draining waste water from a shopping mall near Woodstock in Southern Ontario. The underground septic tank complex is situated 60 feet behind the mall and consists of three separate concrete tanks set side by side and measuring, internally, seven feet high, eight feet wide and extending for 35 feet, sloping downwards, away from the mall. Each tank is divided into a line of three chambers, through which sewage slowly flows; it first enters the primary chamber, where dense solids settle, digestion by anaerobic bacteria starts and a crust forms on the liquid surface; it then overflows into the secondary chamber, which provides additional sedimentation, anaerobic digestion and sludge storage capacity, and finally enters the pump chamber, from which effluent products are pumped up to flow away to a leaching field about 300 feet further from the mall. The overall arrangement is a typical design often employed to process waste water on-site.

After one or two years of use, enough septic sludge accumulates to make it necessary to clean out the primary and secondary chambers of each tank. Each chamber can be reached from ground level by removing a man-hole cover and climbing down a shaft two feet wide and 10 feet deep, which opens into the roof of the chamber. Standard cleaning procedure is to drop a hose from a pump truck into the liquid filling the chamber, blow air down the hose to break up crust and sludge and suspend as much material as possible and,

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finally, reverse the pump flow and vacuum out the sewage. To remove heavy sludge deposits, the operator will back-flush and may have to climb down to the floor of the chamber and shovel sludge towards the mouth of the vacuum hose.

The waste disposal team of three men arrived with their pump truck one morning and continued working throughout the day. In the early evening, the owner of the company arrived to check on progress and assist if necessary. The mall closed at 9:00 p.m. After dark, the night watchman realized the pump truck engine was still running, its hose aerating liquid in one primary chamber, but that the site seemed deserted and no lights showed. Ontario Provincial Police and local firemen were called to investigate. Eventually, the four missing waste disposal men were found floating face-down in two feet of sewage in one of the secondary chambers and, with great difficulty, were dragged out.

None wore respirators or safety harnesses. All were dead and their skin had a uniform greenish discolouration.

Subsequent Investigation

The Occupational Health Branch of the Ontario Ministry of Labour was requested to aid in the inquiry that followed. An initial visit was made, but grab sampling of chamber airspaces failed to reveal toxic gases or reduced oxygen content. It was noted that the dead team had not cleaned every chamber, so the decision was made to return and monitor air quality during cleaning of the remaining unprocessed chambers to assess and document the resulting hazards. A second contractor was engaged and tank cleaning was begun. Intermittent grab sampling showed oxygen levels remained at 21 per cent throughout the aeration and vacuuming phases; combustible gases (methane) were not detected and no carbon monoxide (using Drager tubes with lower detection limit of 10 ppm) or carbon dioxide (using Gastec tubes with lower detection limit of 0.25 per cent) was found. Air samples, drawn through standard activated charcoal tubes and subsequently analysed by gas chromatography and mass spectrometry of dioxane extracts, failed to show any low boiling point organic compounds such as solvents, or volatile sulphur compounds such as mercaptans. However, both grab sampling and long-term monitoring using Drager tubes, Gastec tubes and a hydrogen sulphide meter, documented intermittent release of hydrogen sulphide (H_2S), particularly during sludge agitation. In fact, agitation produced rapid fluctuations

in air space H_2S concentration that often exceeded the upper limits of measurement of 600 ppm. Breathing such concentrations of hydrogen sulphide would be expected to cause rapid onset of faintness and fatigue, eye and respiratory tract irritation, loss of consciousness within 15 minutes and death in a further 30 to 60 minutes.[3,4,5]

Autopsy Findings

At autopsy, green discolouration of skin and organs was noted and sewage was found in the major air passages and stomach of each body. Blood analysis showed sulphide and traces of methane. No carbon monoxide was detected. The cause of death was stated to be aspiration of sewage.

Comment

Sewage gas contains 20–30 per cent carbon dioxide and 50–70 per cent methane, with variable traces of other gases such as ammonia, carbon monoxide, hydrogen, nitrogen and hydrogen sulphide.[6] While gases lighter than air (specific gravity unity) such as hydrogen (specific gravity 0.07) and methane (specific gravity 0.55) tend to rise and escape from vents, gases heavier than air such as carbon dioxide (specific gravity 1.53) and hydrogen sulphide (specific gravity 1.19) remain behind and fill low-lying spaces and may displace other gases like oxygen. Gas evolution and distribution from septic systems is modified by many factors such as temperature, sewage flow, atmospheric conditions and the addition of chemicals to unblock drains, such as sulphuric acid, which reacts with metallic sulphides to release hydrogen sulphide. Disturbance of sewage sludge and agitation of septic tank liquid may release large quantities of trapped methane and hydrogen sulphide.

Ontario Provincial Police subsequently pumped out and searched the chamber where the deaths occurred. In it, they found a metal angle joint belonging to the vacuum hose of the dead team. In the absence of evidence of foul play, the conclusion was that the chamber was pumped out and one man climbed down into the sludge, without respirator, safety harness or other appropriate precautions, to retrieve the metal joint, which had fallen in. He was sufficiently incapacitated by hydrogen sulphide lying in the system to be unable to climb out, and was followed by the others in vain attempts at rescue. Unconsciousness ensued and

the men drowned in sewage, which was still slowly flowing into the chamber.

Uniform green discolouration of skin and other organs is noted at autopsy when hydrogen sulphide poisoning has occurred. It may be contrasted with the patchy green discolouration produced by natural decay processes.

Hydrogen Sulphide

Hydrogen sulphide is a colourless flammable gas. It is soluble in water, slowly reacting with absorbed oxygen to give a turbid solution containing elemental sulphur. Mixtures containing between 4.3 per cent and 46 per cent by volume with air are explosive. The ignition temperature is 260°C. Hydrogen sulphide is produced by anaerobic decomposition of waste proteins and peptides, which contain sulphur, and by anaerobic reduction of sulphates. It is a waste product of various industrial processes such as tanning, the manufacture of viscose rayon, wood pulp and metal and petroleum refining. As a raw material, it is used in the synthesis of sulphides, sodium hydrosulphide and many organic compounds containing sulphur. It is also used in the nuclear industry to extract the moderator deuterium oxide from water.

Hydrogen sulphide has an odour of rotten eggs detectable at concentrations as low as 0.02 to 0.003 ppm[7] and unpleasant above 3.0 ppm. Prolonged exposure to concentrations exceeding 100 ppm causes olfactory fatigue and so the higher and more dangerous the concentration of gas, the less warning provided. Health effects depend on concentration, as shown in the Table, duration of exposure, level of physical exertion and predisposing health problems. Traditionally, three categories of poisoning are recognized:

1 Chronic poisoning is associated with single or intermittent long-duration exposure to low concentrations (below about 100 ppm), which do not produce subacute or acute effects. Vague neurasthenic and otoneurological symptoms are described, including fatigue, loss of appetite, nausea, insomnia, irritability, dizziness and headaches. There is conflict in the literature about the validity of this category since a consistent set of objective symptoms is lacking.

2 Subacute poisoning, generally noted after cessation of exposure lasting several hours or after repeated exposures to mid-range concentrations between 50 and

500 ppm, causes direct local irritation of the mucous membranes of eyes, respiratory tract and proximal digestive tract, but does not terminate in acute poisoning even if exposure is prolonged. Effects are aggravated by high humidity. Conjunctival irritation is the commonest symptom, leading to corneal ulceration, keratitis, blepharospasm, eye pain, blurred vision and photophobia. Respiratory tract irritation causing coughing, bronchitis, rhinitis and pharyngitis is described. Pneumonitis may occur with dyspnoea and pulmonary oedema developing, sometimes terminating fatally. Other, less specific, symptoms, like those associated with chronic poisoning, also occur.

3 With a single exposure to a high concentration (above 500 ppm), acute poisoning may supervene. This is characterized by rapid onset of systemic poisoning, with central nervous system symptoms predominant. Between 500 and 1000 ppm, there is stimulation of the respiratory centre with hyperpnoea, sudden fatigue, dizziness, and collapse in minutes. Consciousness is lost and breathing stops. After initial apnoea, breathing may restart but respiratory arrest is usually complete after 30 minutes and cardiac arrest 10 minutes later. If the subject is rescued and resuscitated, recovery is usually prompt and complete, but neurological and electrocardiological sequelae have been reported. Exposure to concentrations above 1000 ppm may cause immediate collapse, respiratory paralysis and convulsions.

Health Effects of Hydrogen Sulphide Gas at Increasing Concentrations.

Effect	**Concentration**	
	ppm	mg/m^3
odour threshold	0.02	0.14
offensive odour detected	3–5	4.2–7.0
conjunctival irritation	50– 100	70– 140
olfactory fatigue	100– 250	210– 350
acute poisoning with pulmonary oedema and dysrhythmias	300– 500	420– 700
hyperpnoea, apnoea collapse	500–1000	700–1400
immediate collapse, apnoea and convulsions	1000–2000	1400–2800
Reference Levels		
time weighted average exposure criterion[11]	10	14
short term exposure criterion	15	21

Hydrogen Sulphide Metabolism

Endogenous hydrogen sulphide produced in the gut is normally converted to sulphates and thiosulphates and excreted through the kidney. But the capacity of this normal detoxifying mechanism can be exceeded by inhalation of high concentrations. This results in the formation in the blood of greenish 'sulfhemoglobin', a poorly characterized complex with an absorption maximum of 620 nm whose exact composition depends on oxygen tension.[3] Acute poisoning is not the result of hydrogen sulphide blocking oxygen transport by haemoglobin. Recent work shows[3,4,5] that poisoning occurs at tissue level from the formation of sulphides of various metal cations, cofactors for optimal enzyme activity and from direct inhibition of cytochromes, which are haem-containing enzymes in the key respiratory electron-transport chain. Hydrogen sulphide and cyanide have similar toxicological effects and both are highly specific inhibitors of cytochrome aa_3.

Treatment

Removal from exposure by suitably protected personnel is the first and most important action to take in the therapy of acute poisoning. There have been reports of recent successes in severe cases with hyperbaric oxygen therapy[8] in conjunction with general supportive measures. Treatment with intravenous sodium nitrite is often recommended,[9] but its value is controversial.[10]

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News and Notes

Academy of Medicine — Toronto

The academy's Occupational Medicine Section began the 1981–82 season with a talk, on October 1, 1981, by Dr. Ann Robinson, Assistant Deputy Minister of the Occupational Health and Safety Division of the Ministry of Labour. Dr. Robinson's talk was entitled 'Toxicology' and she presented a general overview of this topic. A question period followed with an informative discussion on possible future developments in toxicology and biological sampling.

On December 3, 1981, Ministry of Labour personnel discussed Human Rights for the Handicapped in the Workplace. The legislation, with its implications, was presented together with a report on projects for handicapped workers in Hamilton, Ontario. The presentations were well received.

'The Computer and Occupational Medicine' was the topic for the January 7, 1981, meeting. Dr. Jim Perkins of IBM discussed how the computer will affect occupational physicians in the future.

Future Program –
February 4th, 1982 – The Occupational Health Program — What to Start and Stop?
April 1, 1982 – Fit with Limitations
June 3, 1982 – Annual Dinner

American Occupational Health Conference

The next American Occupational Health Conference is scheduled for April 1982 in Toronto. The program is well underway. Early reports indicate that the topics to be discussed will be interesting and informative with a strong Canadian input. A large attendance is expected. The Canadian Council of Occupational Medicine is co-sponsoring the meeting with the American Occupational Medical Association.

Canadian Board of Occupational Medicine

The Canadian Council of Occupational Medicine (CCOM) was established in 1972 as a federation of provincial societies. The council representatives are appointed annually by each provincial medical society. The council is an affiliated organization of the Cana-

dian Medical Association and acts as a national voice on matters of occupational medicine.

An early interest of the council was the matter of professional accreditation for full-time physicians in the field of occupational medicine. Discussions were carried on with the Royal College of Physicians and with the Canadian College of Family Physicians. These discussions culminated in the establishment of the Canadian Board of Occupational Medicine (CBOM). The CBOM was incorporated in October 1980. The board set up a committee to look into the certification of full-time physicians, their eligibility requirements and the examination procedures to be used. At the present time, the board has certified 22 members by examination and they have given recognition to 11 emeritus members. The board recognizes the great contribution made by part-time physicians in the field of occupational medicine and it is exploring the possibility of associate status for such physicians.

Coming Events

March 7–11, 1982	Annual Meeting of the Society of Toxicology, Boston, Massachusetts
March 23–26, 1982	International Symposium on the Safe Use of Solvents – University of Sussex, Brighton. Details from the Secretariat, 142–144 Oxford Road, Cowley, Oxford, OX4 2DZ Tel. 0865 774051
March 25–26, 1982	Society of Occupational Medicine Spring Meeting, London, England
April 25–30, 1982	American Occupational Health Conference, Toronto, Ontario
May 17–19, 1982	Inter-Noise 82, the eleventh International Conference on Noise Control Engineering, the Jack Tar Hotel, San Francisco. Conference Secretariat: Noise Control Foundation, PO Box 3649, Arlington Branch, Poughkeepsie, New York 12603, U.S.A.
June 9–11, 1982	4th Congress of the International Society for Aerosols in Medicine, Czechoslovakia. Details from Czechoslovak Medical Society, J.E. Purkyne, CS-120 26 Praha 2, Vitezneho unora 31, Czechoslovakia.
June 15–16, 1982	The III International Colloquium for the Prevention of Occupational Accidents and Diseases in the Iron and Metal Manufacturing Industry, Palma de Mallorca (Spain).
July 12–16, 1982	Joint Meeting of the Society of Occupational Medicine and Irish Society of Occupational Medicine, Dublin.

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